

Comparison of Specific Expiratory, Inspiratory, and Combined Muscle Training Programs in COPD*

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Background: Respiratory muscle weakness may contribute to dyspnea and exercise limitation in patients with significant COPD. In an attempt to reduce the severity of breathlessness and to improve exercise tolerance, inspiratory muscle training has been applied in many COPD patients. On the other hand, there is a paucity of data related to expiratory muscle performance and training in COPD.

Methods: Thirty-two patients with significant COPD (*ie*, mean FEV₁, 37% of predicted) were recruited for the study. The patients were randomized into four groups: eight patients were assigned to receive specific expiratory muscle training (SEMT); eight patients received specific inspiratory muscle training (SIMT); eight patients received SEMT and SIMT (*ie*, the SEMT + SIMT group); and eight patients who were assigned to a control group received training with very low load. All patients trained daily, six times a week, with each session consisting of one half hour of training, for 3 months. Spirometry, respiratory muscle strength and endurance, 6-min walk test distance, the perception of dyspnea, and the Mahler baseline dyspnea index (BDI) were measured before and following training.

Results: Training caused a statistically significant specific increase in the expiratory muscle strength and endurance (in the SEMT and SEMT + SIMT groups) and in the inspiratory muscle strength and endurance (in the SIMT and SEMT + SIMT groups). There was significant increase in the distance walked in 6 min in the SEMT, SIMT, and SEMT + SIMT groups. However, the increase in the SIMT and SEMT + SIMT groups was significantly greater than that in the SEMT group. There was a statistically significant increase in the BDI, and a decrease in the mean Borg score during breathing against resistance in the SIMT and SEMT + SIMT groups, with no changes in the SEMT and control groups.

Conclusions: The inspiratory and expiratory muscles can be specifically trained with improvement of both muscle strength and endurance. The improvement in the inspiratory muscle performance is associated with an increase in the 6-min walk test distance and the sensation of dyspnea. There is no additional benefit gained by combining SIMT with SEMT, compared to using SIMT alone. (CHEST 2003; 124:1357–1364)

Key words: exercise performance; expiratory and inspiratory muscle training; sensation of dyspnea

Abbreviations: BDI = baseline dyspnea index; PEmax = maximal expiratory pressure; PEmpeak = peak expiratory pressure; Pimax = maximal inspiratory pressure; PImpeak = peak inspiratory pressure; POD = perception of dyspnea; SEMT = specific expiratory muscle training; SIMT = specific inspiratory muscle training

Table 1—Characteristics of Patients With COPD*

Characteristics	SEMT Group (n = 8)	SIMT Group (n = 8)	SEMT + SIMT Group (n = 8)	Control Group (n = 8)
Age, yr	65.4 ± 3.3	63.1 ± 3.1	62.7 ± 3.0	61.8 ± 3.2
Sex				
Male	7	6	6	7
Female	1	2	2	1
Weight, kg	73.4 ± 2.8	73.5 ± 3.3	71.4 ± 3.0	74.5 ± 3.4
Height, m	1.70 ± 3.5	1.68 ± 3.0	1.69 ± 3.5	1.72 ± 3.8
FVC				
L	2.55 ± 1.2	2.51 ± 1.1	2.47 ± 0.9	2.51 ± 1.3
% predicted	71 ± 4.4	73 ± 4.3	71 ± 4.0	68 ± 4.1
FEV ₁				
L	1.21 ± 0.4	1.33 ± 0.5	1.33 ± 0.6	1.34 ± 0.5
% predicted	43 ± 2.6	44 ± 3.2	45 ± 3.0	43 ± 2.9
6MW, m	270 ± 41	276 ± 44	297 ± 47	293 ± 40
Ptmax, cm	64 ± 4.7	61 ± 4.5	64 ± 4.2	58 ± 3.9
H ₂ O				
PI _{peak} , cm	44 ± 2.6	48 ± 2.7	42 ± 2.6	46 ± 2.7
H ₂ O				
PE _{max} , cm	83 ± 4.7	81 ± 4.0	79 ± 4.4	80 ± 4.1
H ₂ O				
PE _{peak} , cm	55 ± 2.9	51 ± 2.4	55 ± 2.9	50 ± 2.5
H ₂ O				

*Values given as mean ± SEM, unless otherwise indicated. 6MW = 6-min walk.

Training Protocol

Subjects in all groups trained daily, six times a week, with each session consisting of 1 h, for 3 months. The SEMT group received one half hour of SEMT plus one half hour of SIMT with a low load (7 cm H₂O). The SIMT group received one half hour of SIMT plus one half hour of SEMT with a low load. The SEMT + SIMT group received one half hour of SEMT plus one half hour of SIMT, and the control group one half hour of SEMT with a low load plus one half hour of SIMT with a low load.

The training was performed using a threshold inspiratory muscle trainer (Threshold Inspiratory Muscle Trainer; Healthscan). The subjects started breathing at a resistance equal to 15% of their P_{imax} or P_{emax} for 1 week. The resistance then was increased incrementally 5 to 10% each session, to reach 60% of their P_{imax} or P_{emax} at the end of the first month of training. SEMT and SIMT then were continued at 60% of the P_{imax} or P_{emax} and was adjusted weekly to the new P_{imax} or P_{emax} achieved. *Low load* was defined as a fixed resistance of 7 cm H₂O.

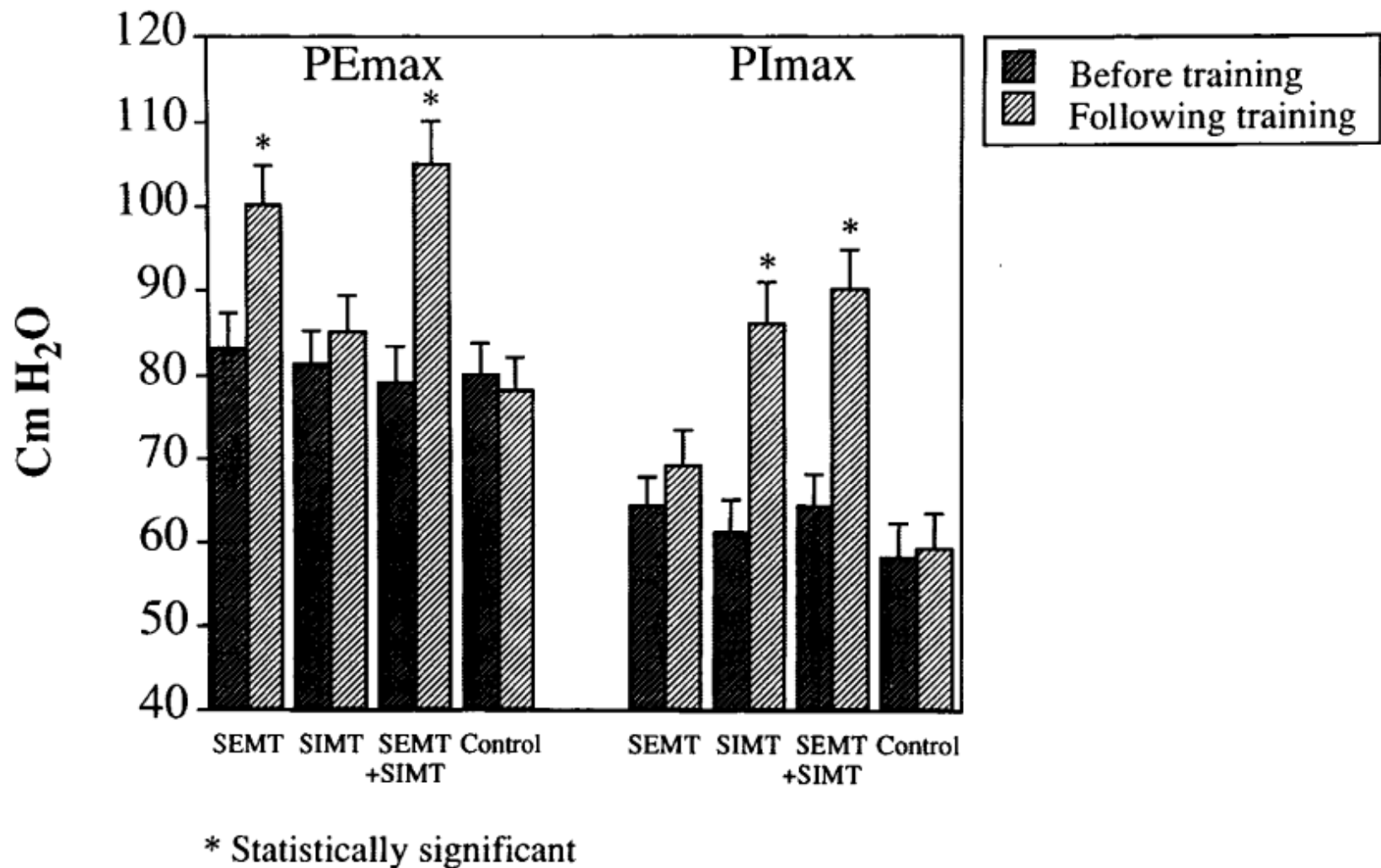


FIGURE 1. Respiratory muscle strength, as assessed by the PEmax and the PImax, before and following the training period.

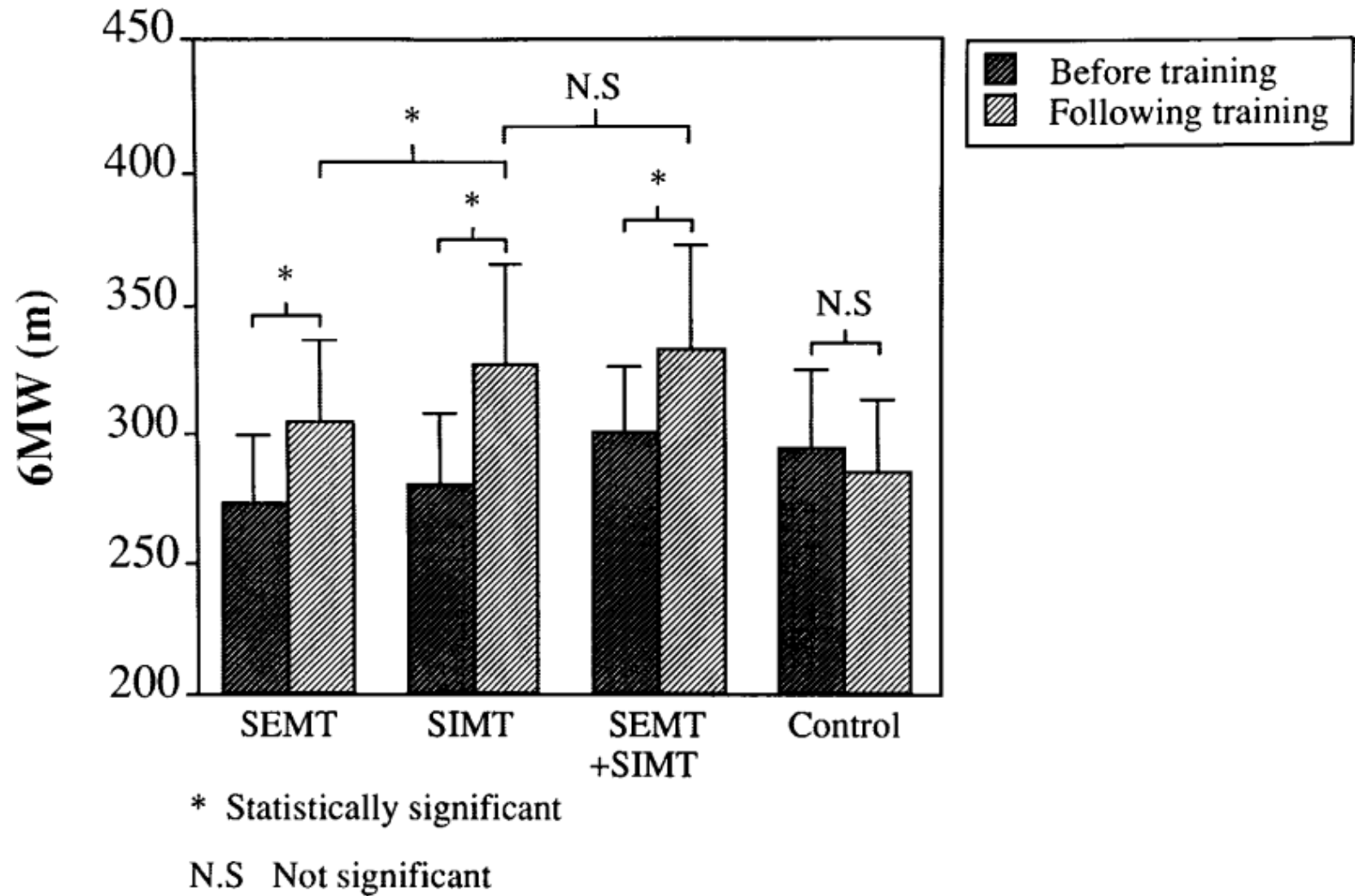


FIGURE 3. The distance walked in 6 min before and following the training period. 6MW = 6-min walk.

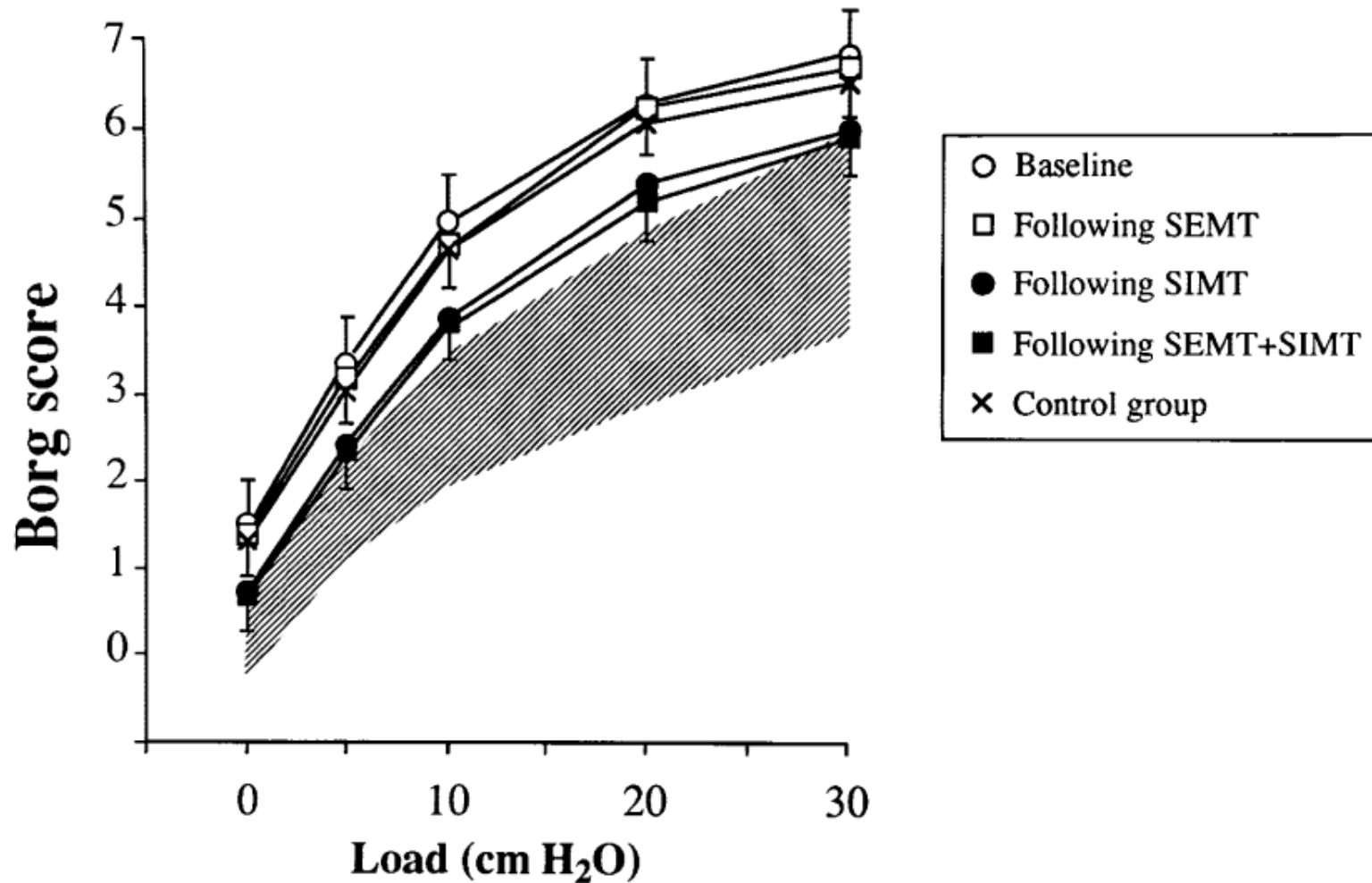


FIGURE 4. Baseline mean \pm SEM POD (Borg score) during breathing against load in all COPD patients and following training in the four groups.